management)

- Major shifts in usage and explosive traffic growth combined with wholly new patterns of communication (e.g., cooperative computing, 'point-casting' and other 'push' applications, browsers, agents and applets, multimedia MUDs -- all involving non-traditional combinations of synchronous, asynchronous, and isochronous interaction)[1]
- Evisceration of competitive boundaries between traditionally distinct sectors or between traditionally distinct sub-segments within sectors (e.g., between computing, communications, and mass media, between telecommunications carriers and CATV, between wireless and wireline, between print and networked information delivery)
- As a consequence of the preceding three, a shift in the balance of power shaping the evolutionary trajectory of information infrastructures from the supply to the demand side, from providers to users as drivers of network evolution.

The Java-equipped, VRML-enabled, World Wide Web is both a product and perfect expression of these discontinuities.[2] It is based on the technological shift toward client-server architectures and object-orientation in computing, the digitized integration

[1]Cooperative computing is the shared use of dispersed computing resources to accomplish a common purpose by physically remote users as in the development of an auto subsystem (e.g., antilock brakes) where designers in several different locations may be simultaneously working on and modifying the database that describes the subsystem for computer-aided design purposes -- any change made by one to the common database must be simultaneously reflected in the work of all, hence the computing is shared and cooperative. Pointcasting is the broadcast of information tailored to individual or small group preferences (in contrast to traditional broadcasting which features the broadcast of undifferentiated information to a mass audience; in contrast to browsing (defined below), it is an example of 'push' technology in which information (e.g., a new software revision) is pushed out to end-users according to preferences they specify rather than being actively searched for and discovered. Browsers like Netscape Navigator are interfaces that facilitate access to information embedded in databases in a manner analogous to browsing for goods in a department store; agents are software tools that automatically sift through databases looking for specific kinds of information specified by a user; applets are self-contained, executable software routines that carry with them both a specific application and the operating instructions necessary to execute it. A MUD, or multi-user domain, is a virtual meeting place where on-line computer users gather to interact -- in simplest form an on-line chat room, in most elaborate form a virtual reality world.

[2]Java is a programming language developed by SUN Microsystems which permits World Wide Web applications to 'come alive' through applets, thus permitting animation, continuous updating and an endless variety of other non-static functions. Java is machine-independent, i.e., applets written in Java can be interpreted or compiled to any computer platform. VRML or Virtual Reality Mark-up Language permits the Web to provide a 3-D experience (like rotating objects to see all sides), and is one of the emerging complements to Hyper-Text Mark-up Language (HTML), the basic language used to create Web documents.

of information formats and availability of higher bandwidth. It enables wholly new patterns of communication that neither traditional broadcast nor telephony could possibly have delivered (i.e., Web applications are neither broadband phone calls nor interactive TV). It blurs mass media, computing and communications in ways that profoundly challenge established suppliers in each of those domains -- as even mighty Microsoft discovered.

The Web's evolution is driven almost entirely by its users who have pioneered all of the new emerging applications -- a distinct departure from the supply-centric traditional model in which a dominant carrier or broadcaster offers a limited menu of service options to subscribers. In the bargain, the Web transcends national boundaries, has fostered applications in every imaginable industry, and has spread like wildfire since its primitive origins in the search for Higgs' Boson at Europe's CERN.

The Web would never have emerged as a service conceived and provided by a single dominant phone company or TV broadcaster. Indeed, profound, discontinuous technological changes like those currently experienced in telecommunications make it impossible to predict either what the value-generating new uses will be or what optimum network and market structures are necessary to deliver them to users. Rather, the uses and optimal structures can only be effectively determined under such conditions of extreme economic and technological uncertainty, through decentralized processes of trial and error, experimentation and learning-by-doing, search and discovery.

Such user-centered processes for generating innovation can only flourish in an environment in which users are granted access to a wide range of choices of facilities, services, networks and network elements. In fact, US policy has gradually, though not always intentionally and still incompletely, been moving toward support of the new user-driven innovation paradigm. The major regulatory decisions taken by the FCC over the past 40 years shifted the impetus for telecommunications innovation from incumbent carriers to network users, alternative equipment suppliers and new entrants. Policies and proceedings like the Specialized Common Carrier, Carterphone, Execunet and Open Skies decisions, and the first and second Computer Inquiries, permitted new entry into equipment, network and service provision. Crucially, they simultaneously protected the competitive space for new entrants to develop into viable commercial firms against entrenched incumbents by mandating interconnection to essential facilities and constraining the incumbents' use of market power.[3] They indirectly fostered user-driven innovation by giving leading edge users --like financial services, energy and manufacturing firms-- broader access to enhanced facilities and communication capabilities. Examples of such enhanced access include higher speed connections, variable bandwidth, minimal error rates, tailored data services and a diverse and growing array of network management, configuration and billing capabilities -- none of which were necessary to provide POTS and were therefore largely unavailable from dominant carriers.

More recently, the FCC has moved to further enhance user-driven innovation and to broaden the possibilities for extended user-choice by enabling deeper access into the incumbent local network. In its Expanded Interconnection Decisions, the FCC permitted data intensive companies to combine their facilities with those of specialized access providers and portions of a local telephone company's networks, in order to obtain reliable, high speed voice and data connections; and in its Third Computer Inquiry, the FCC identified standards for critical software interfaces that were to be made available at affordable tariffed rates.[4] This gradual thrust of US policy to enable user-centered innovation culminated, of course, in the FCC's implementation of the pricing and interconnection provisions of the new Telecommunications Act. Having come so far toward support of user-driven innovation, this would be an inopportune time to back-track. The next section explains why.

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[3] "... established carriers with exchange facilities should, upon request, permit interconnection or leased channel arrangements on reasonable terms and conditions to be negotiated with the new carriers, and also afford their customers the option of obtaining local distribution service under reasonable terms set forth in the tariff schedules of the local carrier." Moreover, as there stated, "where a carrier has monopoly control over essential facilities we will not condone any policy or practice whereby such carrier would discriminate in favor of an affiliated carrier or show favoritism among competitors." See Federal Communications Commission, 29 F.C.C.2d 870; 1971, para 157. See, also, In the Matter of Use Of The Carterfone Device In Message Toll Telephone Service; Docket No. 16942; 13 F.C.C.2d 420; June 26, 1968; MCI v. FCC (Execunet I), 561 F.2d 365 (D.D.C. 1977), cert. denied, 434 U.S. 1041 (1978); MCI v. FCC (Execunet II), 580 F.2d 590 (D.D.C.), cert. denied 439 U.S. 980 (1978); Computer I, 28 F.C.C.2d 267 (1971); Computer II, 77 F.C.C.2d 384 (1980); Computer III *Notice of Proposed Rulemaking*, F.C.C. 85-397 (Aug. 16, 1985)

[4] See Expanded Interconnection with Local Telephone Company Facilities, (Special Access Order) CC Docket No. 91-141, September 17, 1992; Expanded Interconnection with Local Telephone Company Facilities, (Switched Access Order) CC Docket No. 91-141, August 3, 1993; and Third Computer Inquiry cite.

The Economic Rationale for User-driven Innovation

Economic theory increasingly analyzes economic development in the information economy as a dynamic, iterative, cumulative, path-dependent learning process which draws on both technology providers and users. Innovation often emerges from usage, and the subsequent evolution of a technology is shaped jointly by users and providers. Skill-creation and innovation rates play a central role in the resulting economic development. An economy's long run competitive advantage resides in sectors where the rates of learning and innovation are high, which in turn are positively influenced by a broad base of advanced domestic users and sustained user-producer relationships.

This dynamic innovation process is fundamentally unpredictable: neither providers nor users of telecommunications technology, infrastructure and services can foretell which particular technologies will lead to successful implementations, which specific applications will enhance their competitive advantage. The true economic benefits of a particular technology can only be discovered and understood through sustained use and experimentation by a variety of different users, and through the iterative rounds of innovation they inspire from the providers of equipment and services.

This learning-based innovation process can be thought of as a three-step *cycle* in which users first automate, then experiment and learn, and finally reorganize both their economic activities and the network infrastructure and services they use. Consider how the Internet usage evolved into the World Wide Web. Initial Internet functions were typically automated versions of existing capabilities -- email, file transfer and remote login. Once those initial capabilities and the underlying infrastructure was in place, however, Internet users began a long period of experimentation with its possibilities, seeking to better take advantage of the technology. New uses sprouted, built on the old capabilities -- multi-user domains, newsgroups, listservs, etc.

Typically, however, the old infrastructure and capabilities were not flexible enough to support communications patterns substantially different from those they had been designed for. As a result, Internet users were limited in how much experimentation they could undertake until the user-development of WWW protocols. The WWW permitted a thorough re-configuration of the network. And the network re-configuration was complemented by a thorough-going user-producer re-organization as commercialization proceeded. Further cycles of experimentation and reorganization are already underway.

The various steps of this innovation cycle generate two distinct kinds of learning --*learning by using* networking technology and *learning by doing* the network. Across an economy as a whole, such learning is only generated by sustained, varied interactions between a competitive, diverse base of providers and a broad and diverse base of advanced telecommunications users. Importantly, the broader the producer and user base, the wider the range of experimentation will be. In turn, user-driven innovation will then cover a broader spectrum of the technology's possibilities, and explore a broader set of combinations among individual applications. The resulting experimentation with a wider set of possible technology trajectories is less likely to result in "lock-in" to what could be, in the short-term, an attractive arrangement but could turn out to be, in the long-term, an economically and socially sub-optimal path.

With respect to communication technologies, the breadth of both provider and user bases is particularly critical for two reasons. The first draws on a broadly understood conception of network externalities. At any given time the value of a network application directly grows with the number of users connected to the network and able to use that application. As an increasing number of economic activities are being supported by the network, the incentives to invent new applications will grow with the reach of the network. Similarly, the value of a new application for any individual user will also grow with the reach of the network. As a result, the incentives to innovate for providers will similarly grow with the reach of the overall network, and the effectiveness of the interconnection between their individual network and the overall network of networks. And finally, some new applications will only be possible if they can depend on a network with broad reach (for example, electronic town meetings can only work if all community members have access to the network and applications that support the discussion, down to the level of broadband access to the home).

The second reason results from the dynamic, iterative nature of network-based innovation processes. Over time, broad user and producer bases will result in greater cumulative innovation: a broad user base implies a broader spectrum of sources for new ideas and a broader set of possible ways to link and interconnect individual experiences into multifaceted networked applications; a broad and diverse base of product and service providers will expand the range of interconnection possibilities which will be critical to leveraging synergy among diverse individual networks.

The Path to be Taken

Such competition and user-driven innovation processes generate broad economic benefits dwarfing those that might result from the innovations of any individual supplier or provider. A diverse set of users, capable of effectively interacting with a diverse array of efficiently interconnected service, network and facilities providers, providing a variety of networking infrastructures, together create the necessary conditions for user-driven innovation and the virtuous economic growth that follows. Safeguarding the possibilities for user-driven innovation by continuing to nurture flexible and affordable access to facilities, services, networks and elements of dominant incumbent networks, must become an explicit rationale of US policy.

The US is poised for another spin around the virtuous cycle of innovation, service development, network usage, and network development. Once again, new services entrants, hardware and software developers, business users, and now residential users with increasingly large demands for reliable, high-speed data switching and connectivity, are driving the innovation process in communications. And once again, user needs are outpacing the capabilities of the existing public switched telephone network. No one can predict what combinations of facilities and services will best meet user demands. *We can, however, predict that user needs are likely to be fully met only with affordable access to the broadest practicable array of networking possibilities: That is why the essential first step to an explicit policy focus on user-driven innovation is full implementation of the FCC's Local Competition Order.* The FCC's order requires comprehensive access to network components.[5] As long as they control necessary passage

[5] Implementation of the Local Competition Provisions in the Telecommunications Act of 1996, CC Docket 96-98, August 1, 1996.

points, incumbent providers must make all switching, loop, transmission, and operational systems available for interconnection, regardless of the technology embedded in these systems. Only such a broad degree of access is likely to generate the wide array of networking possibilities that can fully support the emerging diversity of user experimentation and need.

The necessary, subsequent second step in the evolution of US policy will be for the FCC to ensure similarly widespread access to future developments in public switched networks -- e.g., access to logical intelligent network elements, or to the implementation of new switching or access technologies like ATM and xDSL -- so long as they continue to be controlled by dominant carriers. As with traditional interconnection, dominant networks will always face internal incentives to control the pace and extent to which they make future innovations in essential facilities available even to their own customers: In some cases existing revenue streams will need to be protected (e.g., desires not to undermine high-margin T1 business is one reason for the slow deployment of xDSL lines which offer data rates equal or higher to T1, for a fraction of the cost). In other cases, there will be an understandable desire to advantage subsidiaries over competitors. But in all such cases, timely access by new entrants and competitors to essential new incumbent network elements is the only way to ensure that customers will have access to the broadest opportunities for the experimentation and learning that leads to user-driven innovation.

Critically, policies that guarantee timely access to future dominant network capabilities need not impede the desire or ability of dominant carriers to further innovate in their own networks. We hinted at the reason why in section two -- the existence of broad network externalities that create strong first-mover advantages for incumbents: In such circumstances, incumbents need no special incentives to innovate. Indeed, the FCC's former chief economist, Joseph Farrell, has made precisely this point with regard to whether extra intellectual property protection is necessary to reward firms in industries like telecommunications where standards and network externalities are important.[6]

[6]Joseph Farrell, Arguments for weaker Intellectual Property Protection in Network Industries", mimeo, 1995

In the end, timely access to essential new capabilities (like xDSL lines) will have broadly positive effects on innovation and network-based economic development. Innovators will make use of the new features and users will explore opportunities for innovation they otherwise would not have faced as timely or cost-effectively. Such considerations argue for US policy to explicitly embrace user-driven innovation by ensuring timely effective access to the widest practicable array of facilities, services, networks and elements of dominant incumbent networks. That is the path to be taken.

Exhibit No. 2

DECLARATION OF GLEN GROCHOWSKI

My name is Glen Grochowski and I am employed by MCI Telecommunications Corporation as a Senior Engineer in Local Network Technology. I submit the following declaration regarding the advantages of xDSL technologies over other available technologies or network topologies.

XDSL ALLOWS DEDICATED BANDWIDTH TO CUSTOMER NOT AVAILABLE WITH OTHER TECHNOLOGIES OR NETWORK TOPOLOGIES

In their petitions, the BOCs argue that cable modems are an example of alternatives to xDSL technologies. While both technologies will provide services, in the long term the telephone network offers significant advantages that the cable network cannot offer. For example, the telephone network offers better reliability, more bandwidth, minimal costs based on an "on demand" incremental cost basis, more funds for R&D investment, more money for upgrades, and more players and competitors.

Further, that cable operators have a much smaller customer base -- by about 33 percent -- than the telephone companies is a fact that should not be overlooked. If the cable operators do not possess the customers at this point, the chance of that customer base growing significantly is unlikely. A recent article explained cable market penetration.[1] Cable operators state that they plan to have a 20-30 million customer penetration of high speed data services by 1999; however, such a plan is very aggressive, particularly considering the competitive market of high speed data services and cable's current 1 percent penetration in that market.

The dedicated bandwidth of xDSL technologies applied to copper loops to individual premises or users is unavailable with any other technology or network topology available on the market today or planned for the future. For example, using ADSL technology applied to a copper loop, an ILEC can deliver a 6 Mbps downstream and 640 Kbps upstream data service to a customer. This ADSL transmission facility is dedicated to the customer. Each customer can therefore receive this service bandwidth if they are within a certain loop

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[1] Michael Arellano, *Gentlemen, Start Your Engines*, Tele.Com, March 1998, at 45-46.

distance from the Central Office.

Due to the nature of the cable plant and the available bandwidth, cable modem technology required to deliver a similar service to a customer provides bandwidth that is shared across multiple customers. In order to dedicate a 6 Mbps downstream and 640 Kbps upstream data service to each cable modem subscriber, a typical US cable plant would only be able to support approximately 75 subscribers. This limitation is due to the fact that the upstream return path on the cable network is limited to 5-42 MHZ and most cable modem systems on the market are capable of a 768 Kbps upstream data rate over 600 Khz. Most cable networks are built to 500-1000 homes per upstream node today. In order to deliver a dedicated quality of service, the cable network would have to be rebuilt with much smaller node sizes to take advantage of dedicated bandwidth cable modem solutions. As a result, cable operators are offering a shared data service, not dedicated. In a shared environment, a cable modem subscriber could receive a full 10 Mbps downstream and upstream service if he were the only subscriber on the system. However as additional subscribers also use the service, the net bandwidth available per customer declines, even with the statistical multiplexing available with packet data services.

The same case of inability to deliver the same bandwidth as xDSL exists with satellite-based service delivery options. For example, the DirecPC Turbo Internet service from Hughes broadcasts 12 Mbps of data from the satellite to its pool of customers and uses an analog telephony modem return path for the individual upstream data channels that is limited to 33.6 Mbps. With this satellite-based data service, there is no way to match the dedicated speed available via ADSL technology.

As can be seen from these points and examples, MCI is not presented with any attractive technology options for broadband service delivery that can match the speed and power and widespread service coverage as xDSL. In addition xDSL technology can be used by MCI to offer competitive access services such as T-1, fractional T-1, NxT1, and multiple voice line services over a single pair, just as the ILECs do today with xDSL technologies applied to their copper loops.

4/3/98

Glen Grochowski

Glen Grochowski
Senior Engineer
MCI, Local Network Technology

Subscribed and sworn to
before me this 3rd day of April, 1998.

TAMMY D. MYERS
Notary Public, State of Texas
My Commission Expires 11-21-98

NOTARY PUBLIC STATE OF TEXAS

Tammy D. Myers
NOTARY PUBLIC

CERTIFICATE OF SERVICE

I, Mellanese Farrington, hereby certify that on this 6th day of April 1998, I served by first-class United States Mail, postage prepaid, a true copy of the foregoing Comments, upon the following:

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